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Driverless Technology Application in Airports

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Abstract: *Driverless technology is advancing at a fast pace, and it has been widely adopted in different industries to optimize operations, increase efficiency and reduce human errors. The aviation industry is not left behind, and airports are increasingly exploring the possibility of using driverless vehicles to improve their operations. This paper explores the different ways in which driverless technology can be used in airports and the benefits that come with it. We discuss the different types of driverless vehicles used in airports, the challenges associated with their implementation and the potential future developments. The paper also analyzes the impact of driverless technology on airport operations, including safety, efficiency, and cost-effectiveness. The application of driverless technology in airports is expected to usher in a period of rapid development in the next few years.*

Keywords: *Driverless technology; Airports; Challenges; Impact; Future Developments*

1. Introduction

The aviation industry is a significant contributor to the global economy, with air transport supporting over 65 million jobs and generating $2.7 trillion in economic activity worldwide[1]. Airports play a vital role in this industry, serving as the gateways to the world for millions of passengers and goods. However, airports are not immune to the challenges that come with managing large and complex operations. Managing airport operations requires coordination between multiple stakeholders, including airlines, ground handling companies, customs and border protection agencies, and others. In recent years, driverless technology has emerged as a promising solution to some of these challenges [2].

Driverless technology involves the use of automated vehicles that can navigate their surroundings without human intervention. These vehicles use a combination of sensors, cameras, and mapping technology to detect obstacles and make decisions about the best route to take. Driverless technology has already been adopted in various industries, including logistics, manufacturing, and mining. The aviation industry is now exploring the potential benefits of this technology in airports.

2. Driverless Vehicles Used in Airports

Various types of driverless vehicles are being used or have already been deployed in airports, with each vehicle designed for a specific purpose. These vehicles primarily include autonomous tugs, autonomous baggage carts and cargo tractors, autonomous passenger shuttles, autonomous passenger boarding bridges, and other types of vehicles [3].

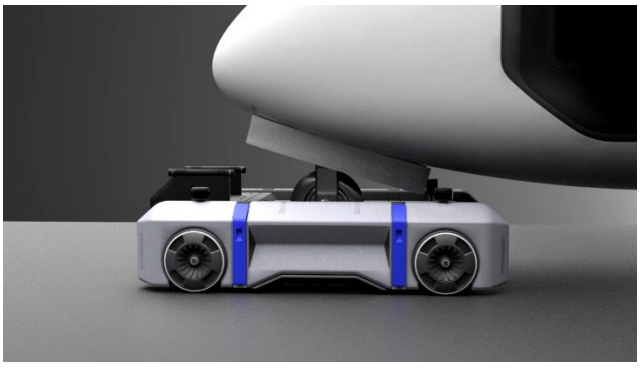

Figure 1: Vertiport flight autonomous tug concept form Moonware.

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Autonomous tugs will be used to tow aircraft from the gate to the runway and back. These tugs are expected to be equipped with sensors that allow them to navigate the airport's taxiways, aprons, and runways. Autonomous tugs can operate in all weather conditions and can tow multiple aircraft at once, reducing the time needed to move aircraft between the gate and the runway, reducing aircraft engine operating time. Currently, autonomous tugs are still in the conceptual stage (Figure 1).

Autonomous baggage carts and cargo tractors are used to transport luggage and cargo between the terminal and the aircraft. These vehicles are equipped with sensors that allow them to navigate the airport's complex network of corridors, tunnels, and intersections. Autonomous baggage carts and cargo tractors can transport luggage and cargo more efficiently than traditional carts, reducing the time it takes to load and unload aircraft. Many airports and airlines around the world have carried out relevant tests. A typical example is that Changi Airport tested the autonomous baggage carts and cargo provided by Aurrigo (Figure 2), and another example is that Japan Airlines tested autonomous tractors to transport baggage at Narita airport (Figure 3).

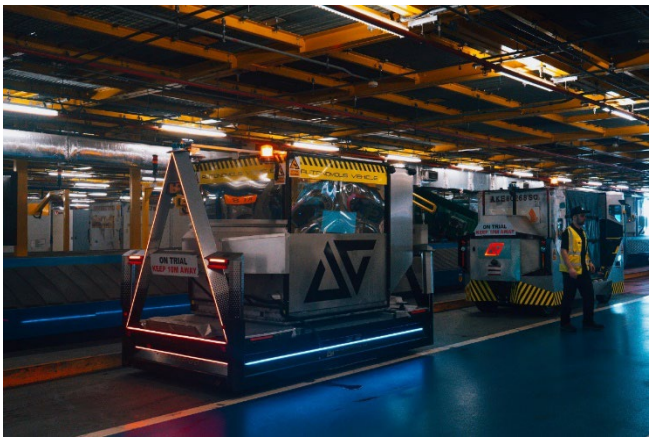

Figure 2: Auto-Dolly and Auto-DollyTug from Aurrigo testing in Changi Airport.

Figure 3: Autonomous tractor TractEasy form EasyMile testing in Narita Airport.

Figure 4: NAVYA autonomous shuttles being tested at John F. Kennedy Airport.

Autonomous passenger shuttles are used to transport passengers between the terminal and the aircraft. These shuttles are equipped with sensors that allow them to navigate the airport's roads and parking areas. Autonomous passenger shuttles can transport passengers more efficiently than traditional shuttle buses,

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reducing the time it takes for passengers to reach their aircraft. As shown in Figure 4, Navya deployed autonomous shuttles in the John F. Kennedy International Airport Aqueduct Parking Lot as one of many test projects worldwide.

Autonomous passenger boarding bridges extend from the airport terminal gate to an airplane, allowing passengers to board and disembark without heading outside and being exposed to harsh weather. The bridges have an advanced cabin door recognition and positioning system that can send data instantly to an artificial intelligence (AI) powered autonomous control system. The first driverless boarding bridge in Asia has been officially put into operation at Chengdu Tianfu International Airport (Figure 5).

Figure 5: The driverless boarding bridge operating in Tianfu Airport

Other driverless vehicles include autonomous patrol cars (The case is shown in Figure 6) and self-driving snowplows (The case is shown in Figure 7), mainly used for airport perimeter patrol and runway snow clearance to reduce the need for manual labor and labor intensity. In addition to the cases mentioned above, there are other potential airport applications, such as catering trucks and de-icing vehicles, among other specialized airport vehicles.

Figure 6: Autonomous snowplows from Yeti Move operating in airport.

Figure 7: Autonomous ATV form ACAMP patrolling in Edmonton Airport.

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3. Challenges Associated with Implementing Driverless Technology in Airports

While driverless technology has several benefits, its implementation in airports also presents several challenges. These challenges include regulatory and legal issues [4], cybersecurity concerns, and the need for extensive testing.

Regulatory and legal issues are one of the biggest challenges facing the implementation of driverless technology in airports. Governments and aviation authorities are yet to establish clear guidelines and regulations on the use of autonomous vehicles in airports. These guidelines and regulations are essential to ensure the safety and security of passengers, employees, and aircraft.

Cybersecurity concerns are another challenge facing the implementation of driverless technology in airports. Autonomous vehicles rely on advanced software and communication systems, making them vulnerable to cyber-attacks. Hackers can take control of these vehicles, causing accidents, and disrupting airport operations.

Extensive testing is necessary to ensure the safety and reliability of driverless vehicles in airports [5]. The testing process should cover all aspects of the vehicle's operation, including navigation, obstacle detection, and communication systems. Extensive testing can be time-consuming and expensive, but it is essential to ensure the safety and efficiency of driverless vehicles in airports.

4. Countermeasures to the Challenges of Autonomous Driving

To address these challenges, airlines, airports and management departments have carried out application tests, issued relevant policies and standards, and promoted the application process of autonomous driving in airports.

Extensive tests have been conducted of the application of driverless technology in airports, such as Beijing Capital International Airport, Changi Airport, and Heathrow Airport. These tests prove the feasibility of applying driverless technology to airports [6].

In October 2021, the Civil Aviation Administration of China (CAAC) released the "Airport Unmanned Driving Equipment Application Roadmap (2021-2025)." The "Roadmap" divides the application of unmanned driving equipment in airports into different development stages as "by 2022", "by 2025" and "long-term", and proposes the main tasks of each stage [7]. The CAAC planned that by 2025, airport unmanned driving equipment will achieve the goal of basically improving the standard system, comprehensive coverage of inspection and verification, fully launching demonstration applications, and forming a large-scale technical reserve.

Additionally, in November 2022, the CAAC's Airport Department solicited opinions on the industry standard "Technical Requirements for Unmanned Equipment in Civil Airports (Draft for Comments)" and "Testing Specification for Unmanned Equipment in Civil Airport (Draft for Comments) [8]." The solicitation was open to various civil aviation regional administrations, airlines, service providers, airport companies, affiliated units, civil airport specialized equipment inspection organizations, and related equipment manufacturing companies. The "Technical Specification for Unmanned Equipment in Civil Airports (Draft for Comments)" standard specifies the design, manufacturing, usage, and acceptance criteria for Unmanned Equipment in civil airports. It encompasses terms and definitions, general requirements, technical requirements for unmanned boarding bridges, technical requirements for unmanned mobile equipment, as well as signage, among other content. The "Testing Specification for Unmanned Equipment in Civil Airport (Draft for Comments)" standard outlines the testing procedures for autonomous driving equipment used in civil airports. These two standards are applicable to the conformity inspection of unmanned passenger boarding bridges and unmanned dedicated mobile equipment used within airport premises. In January 2023, a final review meeting was convened. However, the industry standards have not been published or implemented up to the present, indicating that there are still other influencing factors at play.

In November 2023, the China Civil Airports Association sought opinions on the group standard "Guidelines for the application of autonomous driving vehicle in the aerodrome [9]." This standard defines the framework requirements for the application of autonomous driving in civil airport movement areas, including requirements for cloud control platforms, autonomous driving vehicles, roadside equipment, communication, and operational safety.

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5. Impact of Driverless Technology on Airport Operations

The implementation of driverless technology in airports has the potential to impact airport operations positively. Some of the benefits of using driverless vehicles in airports include increased safety, increased efficiency, and reduced costs.

Driverless vehicles can improve safety in airports by reducing the number of accidents caused by human errors. Autonomous vehicles do not get tired, distracted, or intoxicated, and they can react faster to unexpected situations. This makes them safer than human-operated vehicles, reducing the risk of accidents in the airport.

Driverless vehicles can also increase efficiency in airports by reducing the time it takes to transport passengers, luggage, and cargo between the terminal and the aircraft. Autonomous vehicles can navigate the airport's complex infrastructure more efficiently than traditional vehicles, reducing the time needed to complete airport operations. This can lead to faster turnaround times for aircraft, reducing delays and improving the overall efficiency of the airport.

Finally, driverless vehicles can reduce costs in airports by reducing the need for human labor. Autonomous vehicles can operate without a driver, reducing the need for drivers and associated labor costs. This can lead to significant cost savings for airports, making them more competitive in the global aviation market.

6. Future Developments in Driverless Technology for Airports

The future of driverless technology in airports looks promising, with new developments expected to emerge in the coming years. One of the most significant developments is the use of autonomous luggage/cargo transport vehicles. These vehicles can automatically transport luggage and cargo to and from the aircraft, reducing the need for human labor and improving efficiency. The use of autonomous baggage/cargo transport vehicles can also reduce the risk of lost or damaged luggage, improving the overall passenger experience.

Another development expected in driverless technology for airports is the use of autonomous shuttles, which can autonomously transport crew and passenger to and from their flights. These shuttles can simplify the tasks of airport personnel, increased passenger frequency, improved overall performance within the airport.

Table 1: Tests of driverless equipment in airports.

Airport	Test time				
	Luggage/cargo transport			Shuttle	Others
Beijing-Capital			Sep-19		
Changsha			Sep-20		
Guangzhou				Mar-17	
Hong Kong			Feb-19	Dec-22	
Heathrow		Mar-18	Jun-19		
Toulouse–Blagnac			Dec-19		
Brussels				May-19	
Christchurch				Feb-17	Jun-19
Changi	Sep-21	May-18	May-22		
Saga			Mar-19		
Narita			Nov-19		
Edmonton					Jul-18
Winnipeg James Armstrong Richardson					Mar-19
Former Pferdsfeld Airfield					Oct-17
Fagernes					Mar-18
Cincinnati/Northern Kentucky			Dec-20		
John F. Kennedy				Oct-22	
Birmingham				Mar-22	

The third development expected in driverless technology for airports is the use of autonomous aircraft tugs, which can tow aircraft from the gate to the runway and back without the need for a human driver. These tugs can be operated remotely, reducing the need for ground staff and making airport operations

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even more efficient.

Based on information gathered from relevant media sources, from January 2017 to November 2023, 23 tests (Table 1) for the application of driverless equipment in airports have been conducted worldwide. This includes 12 projects for testing autonomous luggage/cargo transport vehicles, 6 projects for testing autonomous shuttle buses, and 5 other testing projects. The data mentioned above has provided support for the future development of autonomous luggage/cargo transport vehicles and autonomous shuttle buses. Autonomous tugs are still in the research phase, but due to their significant potential impact on airports and airlines, they remain an important direction for future development.

7. Conclusions

Driverless technology has the potential to revolutionize airport operations, improving safety, efficiency, and reducing costs. The implementation of driverless vehicles in airports is not without its challenges, but with proper regulations and testing, these challenges can be overcome. The future of driverless technology in airports looks promising, with new developments expected to emerge in the coming years. As the aviation industry continues to grow, the use of driverless technology in airports will become more prevalent, making air travel safer, more efficient, and more cost-effective for passengers and airlines alike.

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